Yeshivah U.

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Title:	The Effects of Isolation, Sensory Deprivation and Sensory Rearrangement on Visual, Auditory and Somesthetic Sensation, Perception and Spatial Orientation
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Quarterly Progress Report for Grant NsG 489

(March - May, 1965)

This is a report of progress on Grant, NsG 489, "The Effects of Isolation, Sensory Deprivation, and Sensory Rearrangement on Visual, Auditory, and Somesthetic Sensation, Perception and Spatial Orientation" during the three month period, March 1 - May 31, 1965.

Our previous progress reports have presented detailed descriptions of the development of facilities, systems, and techniques in preparation for studying the effects of sensory deprivation on a 7 day/week, 24 hour/day testing schedule. Beginning early in April of this quarter, we have initiated these studies. The testing of 72 hour isolation Ss continued throughout most of the quarter and will continue at peak level until the end of this grant year.

In the sections below, we will first briefly review the various systems that have been developed and then describe the experiment and the initial results.

I. Research

A. Equipment Systems

Since most of the systems required for placing the S in sensory deprivation, testing his sensory thresholds before and after isolation, and monitoring of his physiological responses have been completed and were described earlier, we will merely specify the relevant equipment and systems which are operational at the present time.

1. Isolation and Testing Rooms

The isolation and testing chambers consist of a suite of five sound-attenuated rooms. The testing room is in the center with two isolation chambers on either side. Audio communication with each of these chambers is possible from the monitoring area in the rear of the large outside room. Monitoring of the activity within the isolation chambers is accomplished through the use of a microphone placed in a parabolic reflector, a closed circuit TV camera and a one-way viewing window.

Within each chamber is a specially-constructed mattress containing nine microswitches, upon which the S reclines during isolation, a chemical toilet, and cans of liquid food, loaves of bread, and jars of water. Cables connect the electrodes from the S to a patch panel from which the signals are transmitted to recording and monitoring equipment in the general monitoring area.

2. Sensory Testing Systems

a. Visual system. The basic unit for visual stimulation is a binocular, six-channel tachistoscope capable of minimum stimulus durations of 100 μsec. It has automatic programming for four channels and is under the control of a logic system which enables exceptionally precise timing and order control.

b. Auditory test system. The auditory system comprises an audio-oscillator, two audio switches with control over attack and decay times, power amplifiers and wide range stereo earphones. Ancillary monitoring equipment consists of an electronic counter and an AC millivoltmeter. The entire system is under the control of the same logic system which controls time and order sequencing of the visual system.

c. Tactual sensitivity testing. The basic instrument currently employed for tactual sensitivity measures is the Semmes-Weinstein Esthesiometer. A new instrument, the microesthesiometer, has been delivered and will be "phased-in" for use in the testing of tactual sensitivity. This instrument is capable of delivering stimuli varying in force from one μgm. to one gm. in one μgm. steps (at the lower levels). Difference limens are tested by means of a device developed by us, comprising a series of weights varying in one gm. steps, with an over-all range of 10-33 gm. Skin temperature is measured on the hand tested, by means of a thermocouple.

B. Seventy-Two Hour Total Deprivation Experiment

Early in April we began the pre- and post-isolation testing of blindfolded Ss wearing ear and hand occluders who were placed in isolation for periods up to 72 hours. The following sections give the method, procedure and results thus far obtained.

1. Sample

Subjects for this experiment were recruited mainly from colleges in the metropolitan area. We have thus far restricted the sample to males from 18 through 40. Subjects were chosen only if they met all of the following criteria: normal intelligence, normal vision, normal hearing, good general health, no known severe emotional problems, no known neurological impairment, and no history of any other serious illnesses. All Ss have been reimbursed for their time spent in the experiment.* Toward the end of the past quarter, we also began the testing of control Ss. It should be noted that these control Ss are drawn from the same population as the experimental

* The rate for a 72 hour S, who remains for the full isolation period, is $70 at the present time.

Ss and, in fact, are not told that they will be controls until the pre-isolation testing has been completed. That is, all Ss come to the laboratory prepared for either contingency and are randomly selected for either condition.

2. Procedures for Preparation of Subject for Isolation

a. Initial interview. The S comes to the laboratory offices, where a research assistant meets him and brings him to the pre-isolation testing area. E then conducts a tape recorded interview, obtaining information concerning visual acuity, auditory acuity, smoking habits, previous major illnesses or accidents, current medical problems, how much S knows about sensory deprivation, and expectations concerning the experiment. E then describes the requirements and conditions of the experiment. The requirements are: that there be only necessary movements, no talking or other production of sounds, and S must remain lying down, except for eating or use of the toilet. The S is then shown the isolation chamber in which he will be staying, and the area from which the E will monitor him, both visually and auditorily. S is told that if he wishes to terminate isolation, he can do so by throwing the switch in the room, which notifies the monitor. This procedure eliminates the last remaining necessity for speech during isolation. He is further told that once the switch is thrown, the decision is irrevocable and he will be taken out within 30 minutes. S is given the opportunity to refuse to participate in the experiment at this time before testing begins.

b. Pre-isolation tests. The test battery is administered to S in the following order.*

(1) Verbal Comprehension. This is a five minute, self-administering vocabulary subtest from the Employee Aptitude Survey Battery (EAS). The test constructors describe the purpose as follows:

". . . measures the ability to use words meaningfully, in communication, thinking, and planning. Performance on this test is highly indicative of reading speed and ability to understand written or spoken instructions. Verbal ability is the most important single aspect of 'general intelligence.'"

(2) Visual Pursuit. This EAS subtest measures speed and accuracy in tracing a line visually through an entangled network of lines.

"This is a special type of perceptual ability which is important for ... personnel whose work requires the use of complex schematic diagrams."

The time limit for this self-administering test is five minutes.

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*Tests (1), (2), (3), (4), (5), (6) and (7) are administered at this time. The electrodes are then attached (c.f. section "c" below) and the rest of the test battery administered.

(3) Space Visualization. "...(this EAS test) measures the ability to visualize forms in space and manipulate objects mentally. ...Space visualization is a strong component of 'mechanical aptitude.'"
This self-administering test takes five minutes.

(4) Time Estimation. The S is required to estimate ten consecutive 10-second periods of unfilled time. The E utilizes a time-and-motion study-board, which consists of a special clipboard and three stop-watches. The actual elapsed time of each of the estimated 10-second intervals is recorded. The following instructions are read to S:
"We are going to measure your ability to estimate time. When I say 'start,' you will estimate 10-second intervals by counting to yourself and tell me when each interval is finished. When the first 10-second interval is over, you will say 'now' and start counting for the second 10-second interval. When the second 10-second interval has passed, you will say 'now,' etc. until you are asked to stop."
This test has been introduced to evaluate estimation of personal time as a result of the extended isolation period.

(5) Adjective Check List. This test was adapted from one in use by Myers and by Zuckerman. The S is presented with a list of adjectives or phrases and is asked to place a check mark next to each which is descriptive of the way he presently feels. The following terms are used: "scared stiff, timid, steady, wonderful, comfortable, nervous, unsafe, terrible, worried, in agony, indifferent, frightened, unsteady, fine, and doesn't bother me." The S is allowed to add any other adjectives which may help in describing his feelings. It is hoped that this test will provide an estimate of the feelings and mood of the S before, during and after isolation.

(6) Hand Strength. The Smedley Dynamometer is used to measure hand strength. The S is seated, and the test is performed with the arms hanging down. The following instructions are read:
"This instrument is for testing your strength and, therefore, you must squeeze as hard as you can. With your arm down at your side, squeeze once as hard as possible."
S responds three times consecutively with one hand and then three times consecutively with the other hand. Order of hands tested is alternated with successive Ss.

(7) Bilateral Tapping Speed. This test utilizes the Weinstein Finger Tachometer, which consists of two one-inch Teflon buttons, mounted on a smooth surface, and connected to individual mechanical counters. The counters register a count only when the button is fully depressed and released. Instructions to S are:

"Place both hands flat (palm down) with the tips of your index fingers above the white buttons. I am going to measure how fast you can tap these buttons with your index fingers for 10-second periods. You must leave your hands and all other fingers perfectly flat against the surface of the apparatus. Be sure to depress the button all the way and to lift the index finger off the buttons after each depression, otherwise the counter does not work. Tap as fast as you can. I will give you six trials, each ten seconds long."

It should be pointed out that S is given the six trials with no rest periods planned between trials, except for the time needed to record his performance and to reset the counters (approximately three seconds). This test, therefore, is one of dexterity and fatiguability of certain finger and arm muscles.

(8) Pressure RL. The response to punctate pressure stimuli is determined by means of the Semmes-Weinstein Esthesiometer, which consists of 20 nylon monofilaments, 38 mm. in length, ranging in diameter from .06 to 1.14 mm. Each filament is imbedded in one end of a plastic rod. The filaments are calibrated with a chemical balance according to the force required to bend them by pressing the tips against the pan.

S is shown the filaments and told that he will be touched with some of them in order to determine the lightest pressure he can perceive. He is told to close his eyes and say "touch" whenever he feels anything on the indicated part of the palm. The Ss are tested on the palm of the nonpreferred hand at the point at which an imaginary line drawn from a point midway between the middle and ring fingers perpendicularly intersects with one drawn from the point of intersection of the thumb with the palm. The filaments are applied for about one second with three to eight seconds between contacts. Starting at various forces, below the anticipated threshold, the stimuli are applied in sequence for a total of four ascending threshold determinations.

(9) Pressure DL. The apparatus for testing difference thresholds for pressure sensitivity consists of a series of 24 micro Fernbach flasks, 5 ml. in capacity, weighted by gunshot and cotton. A smooth plastic disk, 26 mm. in diameter is glued to the bottom of each flask. The standard flask weighs 30 gm. and the comparison flasks vary from 19 to 33 gm., in one gm. steps.

For each judgment, two stimuli, a standard and a variable, are successively placed on the S's nonpreferred palm on the distal half of the fourth metacarpal bone. Each weight is left on the palm for two sec. with a two-sec. interval between stimuli, and a five-sec. interval separating judgments. S is required to judge whether the second

is heavier or lighter than the first (no equal judgments allowed). The first comparison stimulus of each series is started randomly at from 10 to 15 gm. and increased in 1 gm. steps for each succeeding judgment. The threshold is that point in the series at which S judges the variable to be heavier than the standard.

On succeeding trials the order of presentation of the two stimuli is reversed such that for half the trial the standard is presented first, and for the other half, the comparison first. Four threshold determinations are made for each S, with a ten-sec. interval between determinations.

(10) Pain Testing. There are two measures obtained from this test, pain threshold and pain tolerance. The apparatus consists of a tank of circulating 0°C water. The measures are obtained for each hand individually. Testing order of the hands alternate with successive Ss. S is instructed as follows:
"Place your hand in the water up to the wrist. As soon as it becomes painful, tell me, but do not remove your hand until the pain becomes intolerable. Keep your hand relaxed, but do not move it in the water."
Pain threshold is the time in seconds from insertion of the hand until the S reports the sensation of pain. Pain tolerance is the number of seconds from insertion of the hand until the S reports that the pain is intolerable. If no such report is made at the end of three minutes, the trial is terminated.

(11) Auditory RL. Absolute loudness thresholds are tested with the auditory stimulus system described previously. Seated in a soundproofed room, the S triggers the stimulus at approximately five sec. intervals by means of a remote control foot pedal. The stimulus tone (1,000 cps) is presented binaurally through earphones for a duration of 250 msec. The S responds when he hears a tone by pressing a telegraph key. Four ascending series are given, starting well below threshold, at an attenuation of the primary signal of 100 db. For the preliminary trial, the intensity of the stimulus is increased in 10 db. steps until S reports hearing a tone. The four succeeding trials are started 10 db. below the first threshold, increasing in 1 db. steps until S reports hearing a tone. "Catch trials" are randomly interspersed, and any responses during these trials are noted.

(12) Auditory DL. To test difference thresholds for loudness, two signals, a standard and a comparison tone, are each presented for 250 msec. durations at a frequency of 1,000 cps. with a between-stimulus interval of 500 msec. The standard stimulus is set at an attenuation of 40 db.; the comparison stimulus is started at 50 db., and is increased in 1 db. steps. The order of presentation for the standard (A) and the

comparison (B) is ABBA. By means of two telegraph keys, the S reports whether the second signal is louder or softer (no equal judgments allowed). The difference threshold is that point in the series at which S judges the comparison stimulus to be louder than the standard.

(13) Visual RL. S enters the soundproofed isolation test room after a minimum of one half-hour of dark adaptation. An earphone is used for communication, with E who is in the monitoring area outside the test room. S is seated in front of the tachistoscope. (The stool and eyepiece of the tachistoscope had been previously adjusted to the S). The following instructions are then read:

"We are going to measure the minimum amount of light you can see. Put this foot pedal near your preferred foot; step down on the pedal. Every time you do so, you are presenting yourself with a flash of light. Most of the time you will not see this flash of light, but when you do see it, please press this telegraph key in front of you. Step on the pedal about every five seconds.

"When the door is closed and the lights are turned off, I will let you know so that you can take off your blindfold and look into the eyepiece. You must see a circle, if you don't,look around in the eyepiece for it. Look straight at the line on the circle, which is located on the left side of the circle at "9 o'clock." Never look directly at the center of the circle where a dot of light will appear; otherwise you will not see it."

Four ascending trials are presented. The first trial is administered as follows: after S indicates he is ready to receive a signal, a flash of light 1.1 msec. in duration is presented to him. If no detection response is given, the duration of the stimulus is increased in .5 msec. steps for each succeeding stimulus until S responds that he has detected the light. E then reduces the flash duration by .5 msec. and the stimulation duration is increased in steps of .1 msec. until S responds again. This second response constitutes S's threshold for the trial. For trials 2, 3, and 4, the starting point is from .5 to .9 msec. below S's previous threshold. The rest of the procedure remains the same.

(14) Visual DL. This test is conducted in the isolation testing room with a dark-adapted S. Communication with S is through an earphone. The following instructions are read to him:

" Every time you step down on this pedal with your preferred foot, you will see two flashes of light. (Emphasize and repeat.)

" If you judge that the second flash is dimmer than the first, press the left telegraph key; if you think that the second flash is brighter than the first, press the right telegraph key. You must give a response, even if you are not sure. No equal judgments are allowed. Step down on the pedal about every 5 seconds. When the door is closed and the light is off, I will ask you to take off your goggles and look

into this eyepiece. You must see a circle. Look at the line which is located on the left side of the circle at "9 o'clock." The dots will appear at the center of the circle but you must not look at them directly, always look directly at the line."

S is given four trials in ABBA order. The standard stimulus is set at 8 msec., the comparison starts at 3 msec. and is increased in 5 msec. steps until S reports the comparison as "brighter." This duration of the comparison stimulus is taken as the threshold for the trial. In succeeding trials, the comparison stimulus is started at from 1.5 to 2.5 msec. below the preceding threshold.

c. Preparation of S for physiological recordings. The S changes into pajamas, and is then prepared for electrodes in the following manner:

(1) A depilatory cream is applied to five specific areas on the scalp and is then carefully removed after 13 minutes.

(2) His hair is then shampooed with hexachlorophene detergent and dried with a hair dryer for 15 to 20 minutes.

(3) The two electrodes for sensing breathing rate are then attached on the ventral surface of the body at the fifth intercostal space, 1-1/2" horizontally off the vertical lines running down from each of the nipples. The specific areas are first cleaned with acetone, and then burred lightly with a dental burr to remove the chorion layer. The silver-silver-chloride electrode which has previously been prepared with special paste is then attached to the skin with Eastman 910 cement. The electrode is then taped down leaving a small loop of wire for slack, and overlayed with foam rubber and adhesive tape. Impedance measures are made approximately ten minutes after the placement of the electrodes.

(4) The EKG electrodes are next attached three inches above the previously placed pneumograph electrodes. Acetone and burring are again employed to remove the chorion layer and the electrodes are attached. Layers of foam rubber and adhesive tape are placed over both sets of leads in order to protect the electrode and insure the comfort of the S. Impedance measures are also determined approximately ten minutes after placement.

(5) Pretested* EEG electrodes are placed on the S's scalp, in the previously prepared locations. These locations are: vertex, midoccipital, inion (ground),

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* EEG electrodes are tested for offset potentials after allowing them to come to equilibrium in a saline solution; any electrode showing offset potentials of more than 5 mv. is rechlorided.

motor-sensory strip (on dominant side) and temporal (on dominant side). Again, the burring procedure is identical with that previously described and impedances are checked for each electrode after ten minutes. Any electrode pair yielding impedances of over 5,000 ohms are removed and reapplied.

(6) A helmet is now prepared, which serves to cover the EEG electrodes. S's head is covered with absorbent cotton, covering the electrodes completely. The cotton is then securely attached with surgical tape. The electrode wires are placed between the cotton and tape, exiting at a single point. Additional foam rubber and padding (3"-4" thick) are used over the inion and occipital placements.

(7) The nondominant hand is first cleaned with alcohol and GSR electrodes are placed on the middle and ring fingers. Silver disc electrodes are filled with Sanborn Redux paste and applied to the skin, using Eastman 910 cement so that the center of the whirl of the fingerprints and the center of the lumen of the electrodes are concentric. The electrode and wires are taped to the finger. The wires which eventually lead to the cables in the cubicle are then taped lightly on the ventral surface of the wrist and arm.

(8) After urination and/or defecation, S is weighed and instructed that in the future he is to use the toilet in his own chamber.

(9) In order to dark-adapt the S for the visual tests, a blindfold is placed in position and the testing procedure is continued.

d. Placing S in isolation room. S is taken to the isolation chamber and shown the food, how to use the can opener, how to drink the water through the tube, the use of the toilet, and the wet pack cleansing tissues. At this point the occluders are put into position. First, a specially designed cuff is placed upon S's nonpreferred hand. This cuff consists of an aluminum frame which fits over the hand and is strapped to the wrist with a watchband. The fingers are clamped between two additional bars of aluminum padded with foam, and the thumb is strapped to the side of the frame, keeping the hand open and the area between the wrist and the first joint of the fingers suspended. A mitten made of fine nylon mesh is slipped over the aluminum frame permitting ventilation but preventing S from stimulating his hand. A plastic tube with ventilation holes is suspended over the forearm, supported at the distal end by the hand-isolating device and at the proximal end by foam rubber.

A light cardboard cuff with ventilation holes and foam rubber lining around the edges (custom made for each S) is fitted over the nonpreferred hand and forearm. It permits use of the preferred hand (for eating, etc.) while reducing movement and touch stimulation.

For ear-occluders, S wears Straightaway Ear Protectors, Model 10A, which attenuate sound approximately 30 db.

For visual deprivation black light-shields, manufactured by Flents Product Co., are taped to S's face. Small light leaks are sealed with absorbent cotton and black velvet and the shields are taped again. This occluding device allows Ss to open their eyes without seeing light.*

When the occluders are all attached, the electrode leads from S are connected to a cable which leads the signals to the patch panel and thence to the recording equipment outside the isolation chamber. S is placed in a lying position and reminded that he is to lie quietly until the end of the 72 hour period, when he will be taken from isolation. E closes the door and starts a digital clock, specific to each S, which indicates total time spent in isolation. S is continuously monitored throughout the isolation period. Special activities such as eating, drinking, going to toilet, or excessive activity are recorded on specially designed data sheets. Physiological activity is recorded 15 minutes out of each hour for each S during the entire 72 hour isolation period.

3. Postisolation Testing

At the completion of the 72 hour isolation period, or if S wishes to leave before this time, he is removed from the isolation chamber and retested. The tests utilized are basically the same as in the pre-isolation battery, but the testing order is different. This revised order is based upon the desirability of ending deprivation as slowly as possible. Thus, S is taken (led) to the test chamber with all occluders still in place. Furthermore, S had been instructed, before going into isolation, that the Audio RL would be the first test taken after isolation, and to remember the instructions. Therefore, S takes this test before hearing any other sound. The next test is Auditory DL. After this test S's blindfold is removed and he is ready to take the visual tests. Instructions for Visual RL and DL are now given by means of the earphones. Upon completion of the visual testing, the blindfold is again placed on S and the cuffs are now removed so that the Pressure RL and the Pressure DL tests can be given. S is then weighed and the blindfolds removed. The motor tests, that is the dynamometer and bilateral tapping speed test are then administered, followed by pain sensitivity and mental tests. Finally a postinterview is tape-recorded with the S, describing his experiences and feelings during the isolation experience. The electrodes

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* A light is on in the isolation chamber throughout the experiment in order to permit monitoring of S on closed-circuit TV and through the one-way window.

are then taken off, he washes and dresses, is paid and leaves. Measurements are made of the amount of food consumed, water intake and the weight of the toilet wastes.

4. Results to Date

Thus far, a total of 41 Ss have been placed into complete isolation for a planned 72 hours. The actual time in isolation ranged from 3 to 72 hours, with a median of 59 hours. The following section gives the proportion of Ss showing an improvement or a decrement in one of the measures taken. These proportions do not take account of total time in isolation and do not differentiate between various degrees of improvement or deficit. The results reported here are not to be considered a final exposition, but rather as preliminary indications of the trends one might expect to find when the experiment is complete. Obviously, much more complex analyses must be undertaken, e.g., analyses of variance and covariance (with predictor variables such as total time spent in isolation, the total number of movements by S, and changes in cognitive and motor performance). It should also be pointed out that tests of statistical significance have not been performed. Thus, it is not known whether the decrease in hand strength shown by 75% of the Ss was statistically significant. It was decided not to undertake parametric analyses until completion of the data collection phase, but rather to indicate the number of subjects manifesting a change, and the direction of the change. Additionally, until data from control Ss are available for evaluation of familiarity with procedures, practice effects, etc., all interpretations concerning enhancement or decline in performance must be drawn with extreme caution.

a. Vision. Sixty per cent of the Ss improved in visual brightness acuity, while only 51% of the Ss improved in the difference limen for brightness.

b. Audition. As in vision, the absolute threshold for sound improved in 60% of the Ss; while again only 52% of the Ss showed an improvement in the difference threshold for audition.

c. Somesthesis. The results for somesthesis were the reverse of those for audition and vision. The absolute threshold for touch was raised in 59% of the cases; whereas the difference threshold for successively applied weights improved in 70% of the cases.

d. Pain sensitivity and tolerance. Seventy-five per cent of the Ss showed a greater sensitivity to pain and lesser tolerance for pain on the isolated hand, and 78% showed a greater sensitivity to pain and lesser tolerance for pain on the nonisolated hand.

e. Time estimation. Fifty-six per cent of the Ss became more veridical in time estimation following isolation. Approximately half of these had originally underestimated and the other half had originally overestimated the 10-second period.

f. Hand strength. Seventy-five per cent of the Ss showed a decrease in hand strength on the isolated hand and 52% of the Ss showed a decrease in hand strength on the nonisolated hand.

g. Hand coordination. Sixty-one per cent of the Ss showed a decrease in index finger oscillation of the isolated hand, whereas only 48% of the Ss showed this decrease on the nonisolated hand.

h. Cognitive functioning. Of the three subtests of the EAS employed, 47% of the Ss showed improvement on verbal comprehension, 76% showed improvement in visual pursuit, and 57% showed an improvement in spatial visualization.

i. Body weight and temperature. Ninety-two per cent of the Ss lost weight during their time in deprivation. Fifty-six per cent of the Ss showed an increase in hand temperature.

j. Postisolation interview. We have thus far taken a random sample of eight Ss from our initial group and summarized their postisolation interviews. The following report is designed to give the "flavor" of the interviews rather than any hard data. Of the eight Ss, three stayed the entire 72 hours. The remaining Ss remained in isolation for from 27 to 59 hours.

Since many investigators have reported the occurrence of hallucinations in Ss undergoing sensory deprivation, we have selected a number of passages from the interviews which deal with the reports of our Ss concerning hallucinations. We have also included quotations concerning their feelings and general reactions to the isolation situation. It might be noted, in summary, that seven of the eight Ss reported some hallucinatory activity, six of the eight reported visual hallucinations, four reported auditory hallucinations and three reported somesthetic hallucinations. None of the Ss reported hallucinatory odors.

(S D.C.C.: Time in isolation 31:31) "I came out because I was uncomfortable. I debated for quite a while and then I decided to come out. After waking up I would feel a little scared about not seeing where I was. I would talk to myself. It was strange. The fear lasted for about one minute ... I tried to convince myself that I was not out of control of the situation and I was being irrational. I couldn't remember my dreams. I slept less than usual ... no trouble in thinking, didn't try to think. Sometimes worked out logical sequences, clearer in the beginning, later jumbled ... spots of light, pinpoints surrounded by concentric circles in reddish brown. Shifting, going into other shapes, objects, people. No depth, more like painted on sheets. They moved all around. I made them go by pressing on my eyes. My eyes were open and closed."

(S P.I.S.; time in isolation 48:18) "... anxious whenever I woke up. I couldn't lie still for long periods of time. My body would be sweating from bandages and the mattress. My head was wet with sweat. I was anxious to be removed from the situation.... About 24 hours previous to coming out I felt like asking to be let out; I couldn't speak because I hadn't spoken for such a long time and I didn't make a real effort because I didn't feel too strongly about coming out. I slept most of the time except for two 6-hour stretches.... My thoughts started out being concrete and became more abstract on the second day.... What bothered me most was the monotony and boredom.... I felt somebody else was in the room at three separate intervals. Handing me something or taking something out and saying something but not audibly. At three different times I heard a "Hui" noise between my right and left ear. It is hard to describe, how can you compare a light flash with a noise? I am not sure they were real. I saw spots, lights moved, shapes like hexagonal. Snowflake shapes, stars, four inches in diameter, like a giraffe star - 5 prongs at the end - not pointed - rather like snowflake. The kind that floated in space. I could make them come back when they disappeared. My eyes were open. I knew they were not real."

(S R.C.; time in isolation 72:00) "... anxious near the end in anticipation of coming out ... (dreams) I thought I was home. I was playing with some cats. They were generally pleasant. I saw a white cat. It fell off the ceiling and was bleeding. I was not disoriented. ... I had planned to do a lot of thinking, but I didn't. I just sort of existed. Sometimes I sang songs in my head. Thought in terms of ideas more than images. It is hard to remember. I started to do Math but it wasn't worth the effort. ... everything in there was pleasant."

(S T.R.: time in isolation 72:00) "... phobia of enclosed rooms diminished with time ... dreams spilled over into waking state ... started to make jokes to myself, maybe they have forgotten all about me and taken off the weekend ... Walls going out - opening up. Felt as if I had gone out of the room. Had gone out of my body ... The thing I was most denied, I dreamed about most. I felt the need for exercise. I disliked food. I craved for rice and fish. I had been on such a diet for quite a while ... No trouble thinking. My mind was keen and alert. I meditated. I tried not to think. Classical meditation. I was observing myself thinking. I did some problem solving with numbers ... very, very much concerned with time. I had fantasies, pleasant scenes ... I anticipated hallucinations. White light filled the field around me, pulsating for brief periods of time. Light was real in different sense. It couldn't be measured physically."

We plan to analyze the form of the hallucinations and attempt to relate them to various parameters, e.g., time S remained in isolation, change in thresholds, etc.

C. Visual Isolation Experiment

During the past quarter, an experiment was initiated to study the effects of visual deprivation.* In this research there will be sixty four Ss, eight groups with eight per group.

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* This research is being conducted primarily by a doctoral candidate in psychology (not a member of the staff) whose dissertation is being sponsored by the principal investigator. The tachistoscope being used in the experiment was obtained with funds from another grant.

1. Testing Schedule

Four groups are being tested pre-isolation and retested at intervals of 6, 12, 24, and 48 hours. As a partial control for the effects of repeated testing, and breaking of isolation, four groups will be tested pre-isolation and then only after 48 hours of isolation.

2. Isolation Conditions

Visual isolation is obtained by covering the left (2 groups), or the right (2 groups), or both eyes (2 groups) with opaque eye patches carefully taped to prevent light leaks. Two control groups will also be run with neither eye isolated. Activity in other modalities (or with the nonisolated eye) is permitted through the use of radio, TV, books, etc. Periodic exercise will be instituted for all Ss. Control Ss will be maintained under the same conditions.

3. Test Battery

The following visual tasks will be employed: thresholds for absolute brightness, acuity (using a modified Landoldt Ring Test), perception of curvature, perception of geometric forms, perception of nonsense syllables and the perception of saturation of various hues. Tests of the nasal and temporal field in the dominant eye will be performed.

4. Progress to Date

Thus far, pilot studies have been completed for most of the stimuli. However, problems with the development of stimuli for color perception have not been entirely solved. It is anticipated that this problem will be solved (or the test dropped from the battery) shortly, and the experiment will begin.

II. Administration

A. Personnel

Augmentation of the staff to the number required for 7 day/week, 24 hour/day testing and monitoring of isolation Ss has been accomplished. Training of personnel continued throughout the quarter. This involved both the indoctrination of new research assistants and continual refinement of procedures by previously trained personnel. At the present time, in addition to the principal investigator and two research associates, there are a total of 15 research assistants currently working

either full-time or part-time on the grant. Dr. E. A. Sersen has resigned from the staff, to accept a directorship of a laboratory.

B. Scientific Meetings and Site Visits

1. NASA-University Program Review Conference

This Conference, held from March 1-3 in Kansas City, Mo., was attended by Dr. Weinstein and Dr. Richlin. They obtained a considerable amount of information concerning the scope, past results and future goals of NASA's University program. Informal conferences were held with Dr. H. E. Newell and with Dr. T. K. L. Smull, and members of his staff: Dr. J. T. Holloway, Dr. F. D. Hansing, Dr. J. R. Craig III, and Dr. D. C. Holmes.

2. Grumman Aircraft

On April 1st, Dr. Weinstein and Dr. Richlin visited Dr. N. Freeberg at Grumman Aircraft, Bethpage, L. I., N. Y. The purpose of the visit was to see the LEM simulator and other devices of possible relevance to our grant, particularly for the study of three-dimensional spatial orientation. Dr. S. Deutsch of NASA joined the briefing during part of the day.

The general conclusion was that their methods and instrumentation were too expensive and required too much space to be of use for our present plans. However, it was of considerable interest to "get inside" the LEM and gain a clearer picture of the astronaut's environment and task requirements. Of particular interest was observation of the position taken by the astronaut during redocking in which he may have to maintain a constant, somewhat strained, head position. Our experiments on extra-visual effects of perception may be quite relevant here (c.f. progress report, March 1, 1965).

3. Eastern Psychological Association

EPA meetings were held from April 22-24, in Atlantic City, N. J. Meetings on electrophysiological methods, sensory rearrangement, and brain function were attended by Dr. Weinstein,* Dr. Richlin,* K. Gorny, M. Weisinger,* and L. Fisher*.

* Travel expenses paid by funds from other grants.

4. New York State Psychological Association Convention

The convention was held on April 30 - May 1, at Grossinger, N. Y. Dr. Weinstein* attended papers and symposia on memory, perception, etc.

5. Colloquium on the Pupil

The fourth annual Colloquium on the Pupil was held at the Georgetown University Hospital in Washington, D. C., on May 11-12. Dr. Weinstein and Mr. Weisinger attended both days of the conference, Dr. Richlin and Mr. Fisher attended the final day of the Conference. Considerable information was obtained concerning the latest applications of pupillography and techniques being utilized in this rapidly developing field. Discussions with manufacturers' representatives and other researchers at the meetings, seemed to indicate that the pupillograph being developed for us at the present time will be considerably superior to any now on the market or currently being considered.

6. Meeting of Institute of Electrical and Electronic Engineers (IEEE)

The IEEE meeting was held on May 18th, at the Graduate Center of the Polytechnic Institute of Brooklyn. Dr. Weinstein, the invited speaker, discussed research on sensory deprivation, emphasizing the importance of such research for space travel.

C. Visitors to Neuropsychological Laboratory

1. Dr. T. I. Myers of the Naval Medical Research Institute, Bethesda, Md. visited our laboratory on March 5th. He was mainly interested in the techniques we are utilizing for measurement and recording of physiological variables.

Dr. Myers indicated that he planned to inititate EKG and EEG recordings. He stated, further, that a consultant to his lab was preparing a computer program for EKG analysis, which would be made available to us.

2. Dr. S. Deutsch of NASA Headquarters reviewed the progress of our research effort on April 15th. Dr. Deutsch was able to observe a S being prepared for isolation and the monitoring of Ss in isolation. Additionally, he was shown the equipment and systems which had become operational since his last site visit.

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* Travel expenses paid by funds from other grants.

III. Plans for the Next Quarter

A. Continuation of Ongoing Experiments

1. Seventy-Two Hour Deprivation Experiment

The major effort of the final quarter of the present grant year will be the completion of the experiment on isolating all three modalities for a 72 hour period. As was pointed out in an earlier section, control Ss will be interdigitated with the experimental Ss during this experiment. There will be two such control groups: controls who are pretested, depart to carry on their normal activities, and then return after three days for post-testing; and controls who are pretested and then are placed in the isolation chamber to lie quietly for three days, but without isolation of any of the modalities. Analyses of the data from this experiment will continue during the quarter, with final analyses beginning as soon as the experiment is completed.

2. Visual Deprivation Experiment

The experiment in which only vision is deprived will be completed during the coming quarter, and data analyses will begin.

B. Introduction of New Dependent Variables into the Test Battery

1. Microesthesiometer

The microesthesiometer was delivered at the end of the third quarter. It is presently receiving its final calibration and is being checked out to make it ready for operational use. As soon as these steps have been completed, the microesthesiometer will be introduced into the experimental test battery.

2. Visual Motor Tracking Device

The visual motor pursuit instrument will be delivered to us early in the fourth quarter. It will be given preliminary testing and then added to the test battery.

C. Development of Techniques

1. Evoked Potentials

During this quarter, we will begin preliminary experiments on the study of evoked potentials to visual, auditory, somesthetic, and electrical stimulation. Because of the suprathreshold nature of the stimuli used in evoked potential work, it is not anticipated that we will use the technique on Ss from the present 72 hour

isolation experiment. However, as soon as that experiment is completed, we will begin experiments with the evoked potential technique to study changes which may appear after varying periods of sensory deprivation, and after deprivation within any one or two modalities.

2. Physiological Recording

The continuing difficulty in obtaining adequate records for 72 hours using our present electrodes, and the inability, to date, to obtain the electrodes reportedly developed at NASA's Houston Manned Spacecraft Center, requires the continued investigation of techniques for electrical recording of physiological activity. While working toward a solution of these problems, it is possible that we will be employing certain interim techniques. For example, we may break isolation periodically (e.g., once per day) attach electrodes to the S while in isolation. We would then record the data from the S for perhaps a one hour period, and then switch to another S for an hour of recording, etc.

D. Development of Equipment

1. Pupillograph

The continuing development of the pupillograph will be vigorously pursued during the coming quarter. While it is not possible to predict with certainty, it is hoped that an operational pupillograph will be ready some time during the coming quarter.

2. Spatial Orientation

The development of a spatial orientation device will be continued during the coming quarter. While no final plan for such a device has as yet been devised, a number of suggestions and ideas have been formulated. For example, we are considering a rotational device for the S to identify the orientation of star-like configurations. A Questar telescope has been obtained (with funds from another grant) which may become part of the testing system. We will begin discussions with manufacturers concerning the probable cost and feasibility of some of the ideas generated. It is hoped that a mock-up of a device can be prepared here at our laboratory and some preliminary investigations conducted towards the end of the coming quarter.